Lesson 1: The special challenges of the deep sea

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**Overview:** This lesson will take place at the end of a unit in high school general biology class exploring topics in ecology through extreme ecosystem analysis. Prior to this lesson they will have discussed chemical changes associated with ocean acidification. They will be familiar with food webs and trophic levels and photosynthetic based systems from their previous study of the Polar Regions and rainforests.

**Standards:**

* LS3 (9-11) -8a Students demonstrate an understanding of Natural Selection/evolution by illustrating that when an environment changes, the survival advantage/disadvantage of some characteristics may change.
* LS2 (9-11) -4: Student demonstrate an understanding of matter and energy flow in an ecosystem by explaining how the chemical elements and compounds that make up living things pass through food webs and are combined and recombined in different ways.

**Objectives:**

1. Students will be able to list the biotic and abiotic factors that affect organisms in the deep sea.
2. Students will diagram energy flow in a deep sea environment to explain how energy reaches the deepest levels
3. Students will explain how organisms adapt to deep sea based on observations of physical attributes.
4. Students will be able to trace origin of energy in deep sea to phytoplankton.

**Materials/Preparation Notes:**

* Glow stick
* 5 sets of Photos of 5 deep sea organisms: Anglerfish, ctenophore, hagfish, brittle star, sea cucumber (each feeds differently and has specific adaptations)
* Worksheets for listing attributes of “mystery organism”
* Homework double sided worksheet/reading guide for plankton website

**Instruction:**

**Opening:**  Have a student standing by the lights waiting for signal. Have glow stick open and ready. Tell students that we have learned about the flow of energy in a polar and rainforest environment and today we will visit a very extreme and little known environment… (Cue the lights to be turned off)…the deep sea. (If your are worried about student behavior consider a small battery operated lantern in the back or front of the room to avoid total darkness)

While students are in the dark: Have students guess then list features of ocean life below 1000m (no light, pressure 10atm/m so >100atm, Temperature -1°C to 4°C, and high salinity). State that animals have evolved ways of coping with extreme environments (light glow stick). Ask if anyone knows an adaptation of the deep sea (bioluminescence) ask students for reasons for bioluminescence (find mates, protect from predators, lure prey)

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Turn on lights to continue discussion. Ask students to propose a food web for animals that are living at the very bottom of the ocean. Where does the food come from in a lightless environment? (Plankton) Draw diagram on board to illustrate plankton to bottom feeder movement of carbon. Describe how plankton obtain nutrients (upwelling from ocean currents).

**Activities:** Mystery organism jigsaw activity

* Students will be divided into 5 groups of 5 (preferably they are already seated in groups that were set up at the start of the unit).
* Every student will be given a worksheet and one of the five photos.
* Students will then need to form new groups based on the photo that they have (all sea cucumbers, all anglerfish…..).
* They will need a computer, IPad or other resource (printed materials) for each new group. The new groups will work together to complete the worksheet describing the adaptations of their organism. The teacher will walk around making sure they are on task and keeping track of available time by giving them occasional reminders.
* When all groups have finished their worksheet, explain that they will be returning to their original group. Once there, they will each teach their group about the organism in the photo. Remind them that they will be graded on the completeness of their individual organism sheet and the group generated chart that they will be given when they reform their first group.
* Once each group has completed their organism they all will return to their original groups and explain to their original group how their organism survives in the deep sea. Students will all be given a chart containing the five examples that they will need to fill out as their peers provide the needed information.
* Worksheets will be put in science binders.
* After groups are finished have a brief whole group discussion to review key points on worksheets.

**Closing:**

We studied 5 very diverse organisms that are able to survive the deep ocean in very different ways. What is something that they all have in common? What is the producer that they all depend upon? What would happen to your animal if there was a lot less plankton? What would happen if the ocean currents changed? Could this happen? We need to learn more about phytoplankton.

For Homework: students will be given a worksheet to fill out using the web site (this may be omitted if already covered in Polar system):

<http://earthobservatory.nasa.gov/Features/Phytoplankton/>

**Assessment Notes:**

Class work will be evaluated when notebooks are checked with worksheets assessed for completeness. Questions about key ideas will be included on the end of unit exam.

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Adaptations to the Deep Sea:

Name of organism: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Where is it usually found? (in the water column, on the bottom, at what depth?) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What does it eat? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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How does it obtain its food?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What special adaptations does it have to help it survive?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
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Summary of Deep-sea adaptations Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| Animal | Food | Method of feeding | Special adaptation |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

All of these organisms are (circle one) Producers/ Consumers. This means that they get their energy, carbon and nutrients by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Phytoplankton**

(Use the web page: http://earthobservatory.nasa.gov/Features/Phytoplankton/ to find information.)

What are phytoplankton?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What are some kinds of phytoplankton?

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Phytoplankton are (circle one) producers/ consumers because they \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

All phytoplankton \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_to capture energy from the sun.

Phytoplankton also require nutrients such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and trace \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Phytoplankton consume \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ which they incorporate. When phytoplankton die, it is carried to the deep ocean and consumed.

This \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pump transfers about

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of carbon from the atmosphere to the deep ocean every year.

Phytoplankton thrive in which areas?

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Wind is important to phytoplankton because it drives \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ which contain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_to the surface. The areas where nutrients rise to the surface are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

As the ocean surface warms in response to greenhouse gases, the water column will become

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, with less mixing of nutrients. Phytoplankton productivity will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Based on the information you read, what do you predict will be the effect of global warming on deep sea organisms?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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